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EXAMINER

VU, HUNG K

ART UNIT PAPER NUMBER

2811

DATE MAILED: 07/12/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Application No.

09/819,296

Applicant(s)

PAN ET AL.

Examiner

Hung Vu

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 15 April 2005.
- 2a) ☒ This action is FINAL. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 8-10 and 12-25 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 8-10, 12-21, 23 and 24 is/are rejected.
- 7) ☒ Claim(s) 22 and 25 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

## Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.

## Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date \_\_\_\_\_
- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_

## DETAILED ACTION

### *Claim Rejections - 35 USC § 102*

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 8-10, 12-14, 16-21, 23 and 24 are rejected under 35 U.S.C. 102(e) as being anticipated by Werkhoven et al. (PN 6,703,708).

Werkhoven et al. discloses, as shown in Figures 1-12 (especially Figure 9), a method of manufacturing a multi-layered barrier metal thin film by atomic layer chemical vapor deposition comprising the steps of,

providing a substrate (not shown) in a reactant chamber;

providing a first chemical species comprising a first metal (tungsten) in the reactant chamber;

providing a second chemical species (ammonia, etc.) in the reactant chamber;, wherein the first and second chemical species react to deposit a barrier metal thin film of a metal nitride (432, TiN, TaN, etc.) on the substrate by atomic layer chemical vapor deposition;

providing a third chemical species (Cu) comprising a second metal of a different material than the first metal in the reactant chamber;

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providing a fourth chemical species in the reactant chamber, wherein the third and fourth chemical species react to deposit a second layer of the barrier metal thin film of a second metal nitride (434,  $(\text{WN}_x)_y\text{Cu}_z$ ) directly on the first layer by atomic layer chemical vapor deposition,

wherein the barrier metal thin film deposited on the substrate defines a thickness of less than 100 Angstroms. Note Col. 16, line 36 to Col. 20, line 21. Also noted that, since the chemical species comprising metal react with ammonia, it is inherent that the process is chemical vapor deposition.

Regarding claims 9 and 17, Werkhoven et al. discloses the method further comprising depositing a thin copper film (436) on the barrier metal thin film.

Regarding claim 10, Werkhoven et al. discloses the thickness of the barrier metal thin film is equal to an atomic thickness of the metal nitride. Note Col. 16, line 36 to Col. 20, line 21.

Regarding claims 12, 18 and 24, Werkhoven et al. discloses the barrier metal thin film and the second barrier metal thin film are each chosen from the group consisting of TiN, TaN, and WN. Note Col. 16, line 36 to Col. 20, line 21.

Regarding claim 13, Werkhoven et al. discloses the substrate comprises a trench having a bottom surface and a side wall, and wherein the barrier metal thin film is deposited on the bottom surface and the sidewall by atomic layer chemical vapor deposition such that the barrier metal

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thin film defines a blocking diffusion characteristic which is the same on the side wall and the bottom surface.

Regarding claim 16, Werkhoven et al. discloses the method further comprising providing a fifth chemical species in the reactant chamber and providing a sixth chemical species in the reactant chamber, wherein the fifth and sixth chemical species react to deposit a third barrier metal thin film of a metal nitride on the barrier metal thin film by atomic layer chemical vapor deposition. Note Col. 16, line 36 to Col. 20, line 21.

Regarding claim 19 and 23, Werkhoven et al. discloses the first barrier metal thin film and the second barrier metal thin film together define a layered structure having a thickness of less than 60 Angstroms. Note Col. 16, line 36 to Col. 20, line 21

Regarding claim 20, Werkhoven et al. discloses the first chemical species comprises a metal halide and the second chemical species comprises a nitrogen containing gas. Note Col. 16, line 36 to Col. 20, line 21.

### ***Claim Rejections - 35 USC § 103***

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Werkhoven et al. (PN 6,703,708).

Werkhoven et al. discloses all of the claimed limitations except the time period for conducting each atomic layer in the range of 0.4 to 5.0 seconds. Although Werkhoven et al. does not teach exactly the time period, as that claimed by Applicants, however, it would have been obvious to one having ordinary skill in the art at the time the invention was made to form the barrier during the time period, since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

#### *Allowable Subject Matter*

3. Claims 22 and 25 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

4. The following is an examiner's statement of reasons for allowance:

Applicant's claims 22 and 25 are allowable over the references of record because none of these references disclose or can be combined to yield the claimed method further comprising depositing a third layer of a third metal nitride on the second layer by atomic layer chemical vapor deposition, wherein the third metal nitride is a different material than the first and the second metal nitrides; the method further comprising depositing a third layer of the first metal nitride on the second layer by atomic layer chemical vapor deposition, and depositing a fourth

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layer of the second metal nitride on the third layer by atomic layer chemical vapor deposition such that the multi-layered barrier metal thin film comprises alternating layers of the first and second metal nitrides, as recited in claim 25.

### *Response to Arguments*

5. Applicant's arguments with respect to claims 8, 14 and 21 have been considered but are moot in view of the new ground(s) of rejection:

### *Conclusion*

6. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hung K. Vu whose telephone number is (571) 272-1666. The

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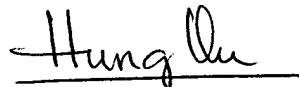
examiner can normally be reached on Mon-Thurs 6:00-3:30, alternate Friday 7:00-3:30, Eastern Time.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eddie C. Lee can be reached on (571) 272-1732. The Central Fax Number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

Vu

June 23, 2005

A handwritten signature in cursive script, appearing to read "Hung Vu", is written over a horizontal line.

Hung Vu

Primary Examiner